



Assessing a potential solution for spatially referencing of historical aerial photography in South Africa

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Duties of South Africa's national mapping organisation

Promote and control all matters connected with those **surveys and services**;

Conduct such **geodetic, topographical** and other relevant **survey operations** as may be required;

Acquire such **aerial photography** or other **remotely sensed imagery** as may be required;

Background

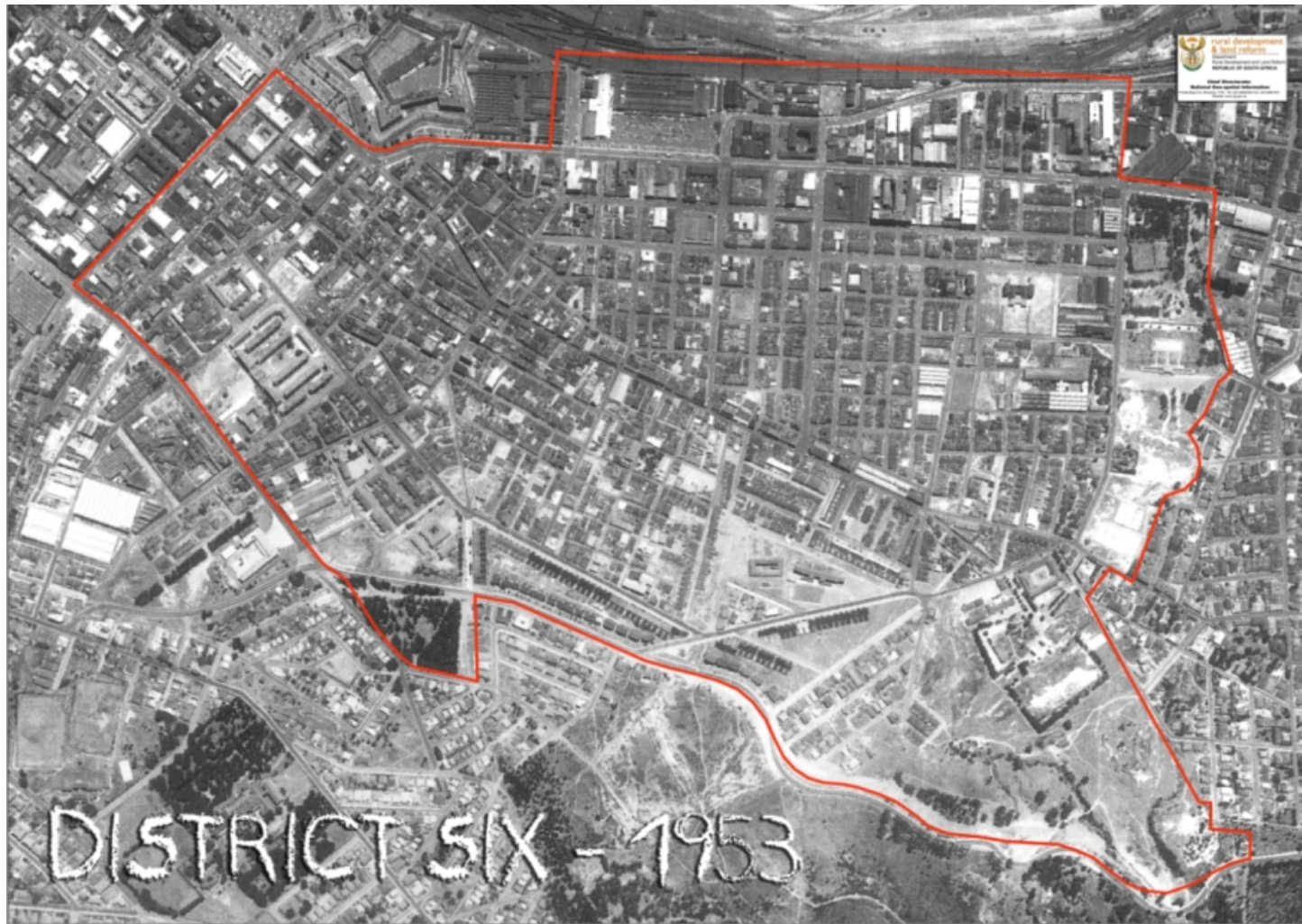
- Historical aerial photography provides a record over time.
- Current repository of pre-1990 – analogue.
- Spatial referencing is required for various applications.
- A method is required to geo-reference large volumes, according to the national standard.

National Standard for orthorectification in South Africa

- *‘ the positional accuracy of the pixels in the horizontal does not exceed five metres at a 95% confidence level*

(Department of Rural Development & Land Reform, 2010)

Evidence of Change over Time Through Imagery



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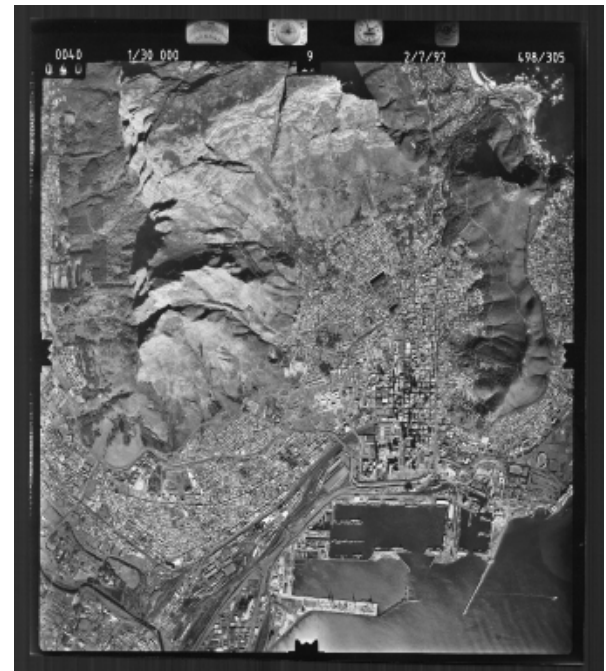


Evidence of Change over Time Through Imagery



Objectives of Research

- Assess current scanning methods;
- Assess potential software solution for processing large volumes of photography;
- Assess the accuracies that can be achieved.



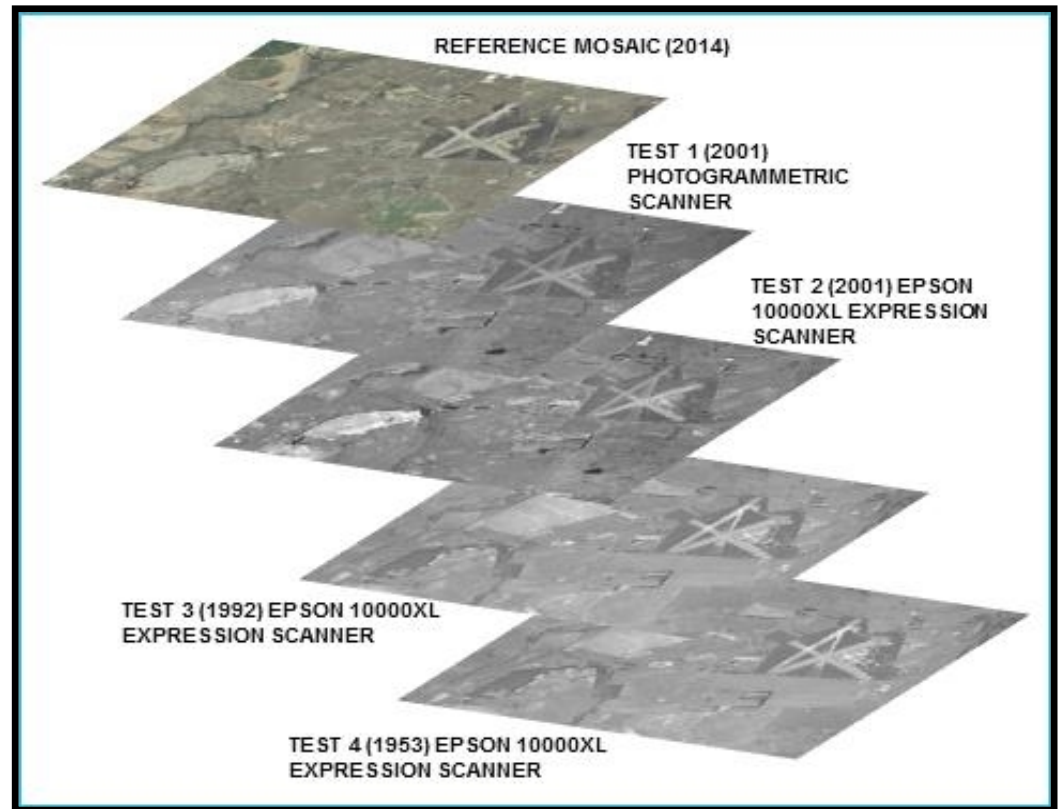
Study Site

- Outside Cape Town city bowl
- 3318DC 1-15
- Mixed land uses
 - Urban
 - Farming
 - Recreational
 - Light & heavy industry
 - Retail
 - Various modes of transport



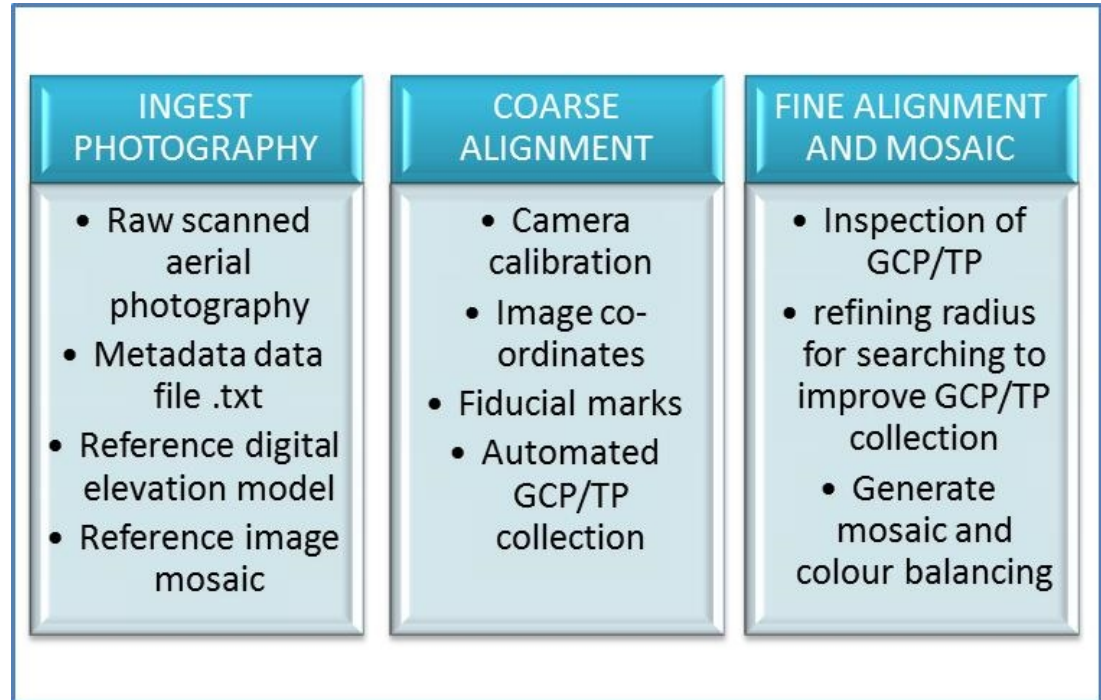
Methodology

- Image-to-image alignment technique
- Ortho-rectification & mosaicking of 3 epochs of photography, 4th epoch as reference image
- Epoch range ± 60 years



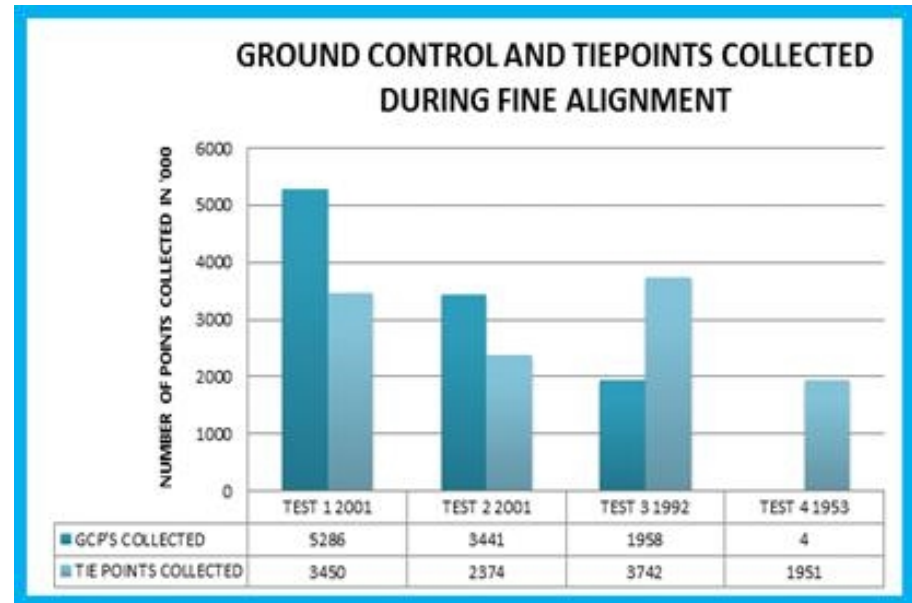
PCI Geomatics HAP software

- Image-to-image alignment technique
- PCI Geomatics HAP software
- Workable solution for georeferencing large volumes
- For NMO's provides a solution for creating a historical context of time series imagery



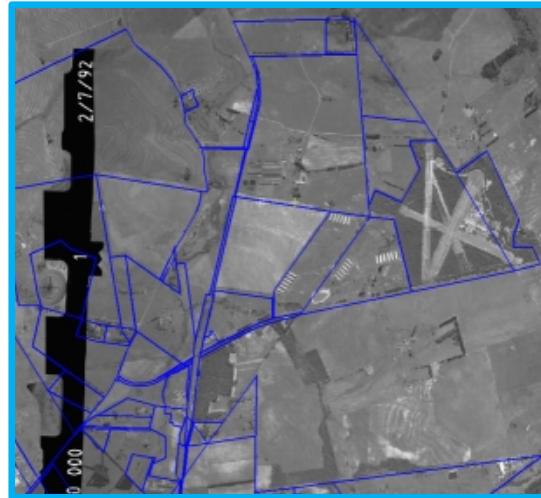
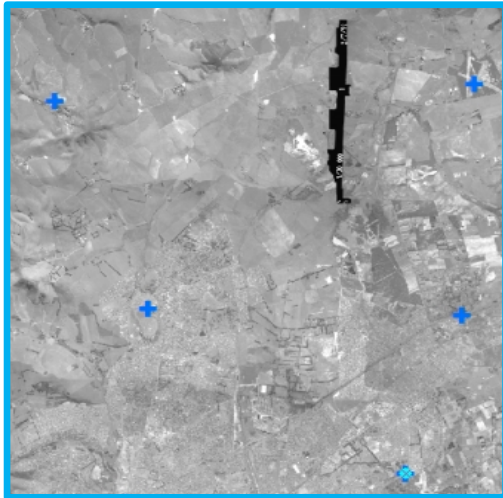
Results of Alignment

- Coarse and fine alignment processes in software apply image-to-image matching techniques by collecting ground control points and tie points in multipath approaches.



Of particular note, was the decrease in the number of ground control points collected as the age difference between the reference mosaic and the test imagery increased, as can be seen in Figure 2 below. Therefore, it was considered prudent to exclude test 4 from any further assessment of the accuracies.

Accuracy Assessment



- Visual approach
- Cadastral overlay
- 9 common points over geographical area
- Distance offsets determined compliance to national standard

JOINS											
REFERENCE MOSAIC to 498/388 HIGH RES				REFERENCE MOSAIC to 498/388 LOW RES				REFERENCE MOSAIC to 498/305 LOW RES			
DISTANCE (m)	DMS			DISTANCE (m)	DMS			DISTANCE (m)	DMS		
4.4	149	49	7.0	6.1	271	52	7.3	68.4	238	28	17.5
5.3	226	13	43.2	21.1	269	7	53.5	53.3	250	39	11.1
2.6	0	0	0.0	35.9	355	54	50.1	86.8	314	59	58.3
0.5	270	0	0.0	8.5	198	26	5.8	28.3	189	41	17.9
2.3	286	27	36.1	9.8	63	59	1.8	4.9	44	10	19.5
7.9	54	27	59.6	14.0	58	24	4.8	22.0	2	23	13.3
10.2	10	48	44.6	24.8	37	0	29.4	16.6	196	2	56.7
4.1	301	14	51.4	10.9	121	36	32.0	37.9	85	41	6.7
2.7	299	2	1.2	17.7	30	40	50.8	42.5	45	15	12.2
4.4	AVERAGE			16.5	AVERAGE			40.1			
3.0	STANDARD DEVIATION			9.5	STANDARD DEVIATION			26.0			

Conclusion

- Current methods of scanning do not yield results in line with national standard.
- Only imagery scanned with photogrammetric scanner conforms to national standard.

Results of test	Conformance	Yes/No		
Test 1	National standard	Results of test	Conformance	Yes/No
Test 2		Test 1	National standard	✓
		Test 2		✗
		Test 3		✗
		Test 4		✗
Test 3		✗		
Test 4		✗		
		✗		

Recommendations

- Workshop best practises for scanning of historical aerial photography.
- Second order orthophotos as new product line.
- Only use imagery as a backdrop, or for change monitoring.
- Add control points to improve accuracies.
- Use an earlier epoch as reference image and ortho-rectify later epoch.

Further research

- Case study in rural area – beneficial for land reform cases.
- Redo research using reference image with smaller age difference.

Relevant literature

- Bhatta, B., 2011, *Remote Sensing and GIS*, Oxford University Press, India.
- Department of Rural Development and Land Reform, Chief Directorate: National Geo-spatial Information, 2010, *Standard for the Ortho-rectification and Mosaicking of Imagery*, (QLAS.SD.15_V1_2010.12.17), Cape Town.
- Mouton, J. 2001. *How to succeed in your Master's and Doctoral Studies: A South African Guide and Resource Book*. Van Schaik Publishers, Pretoria.
- PCI Geomatics. 2013. *PCU Introduces Historical Airphoto Processing (Hap) Workflow*, brochure, viewed 22 September 2016, from http://www.pcigeomatics.com/pressnews/2013_PCI_HAP.pdf.

Thank You

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